Association for Information Systems
AIS Electronic Library (AISeL)

AMCIS 2004 Proceedings

Americas Conference on Information Systems (AMCIS)

December 2004

IS Value at Individual Level: Analyzing Role of the Nature of IS Use

Vikas Jain
George Washington University

Shivraj Kanungo
George Washington University

IS Value at Individual Level: Analyzing Role of the Nature of IS Use

Vikas Jain
George Washington University
vikas_j@gwu.edu

Shivraj Kanungo
George Washington University
kanungo@gwu.edu

ABSTRACT

Value of information systems at the organizational and process levels has been addressed by many IS researchers. However, value-addition of IS at the individual level has not been studied extensively. In this paper, we build on the rich research tradition of linking behavioral antecedents of IS use and extend it to study IS value-addition at individual level. Our study focuses on the antecedents of IS-enabled individual productivity. We conceptualize IS-enabled productivity as a process output which is co-determined by behavioral antecedents and the nature of IS use. We tested our research model by surveying 482 individuals and collected data across two IS applications. Our research model is validated both at the aggregate level and across the two individual IS applications. The study results confirm our proposition that the quality of the use process is as important as the extent or duration of use of an information system while determining IS enabled productivity. Based on study findings, we provide theoretical and managerial implications of the relationship between productivity and IS use.

Keywords

Technology acceptance, IS value, IS use, IS productivity.

INTRODUCTION

Over time, various approaches have been advanced to provide an understanding of the business value of information systems. One important line of research has focused on econometric modelling of IT investments and organizational performance using performance parameters such as, sales revenue, profit, return on assets or stock value performance of the organization (Brynjolfsson & Hitt, 1996; Loveman, 1990; Roach, 1991; Brynjolfsson & Hitt, 1993; Brynjolfsson & Yang, 1999; Brynjolfsson & Hitt, 2000; Devraj and Kohli, 2000). This stream of research helps us understand whether IT investments have any impact on organizational performance. However, some studies (Mukhopadhyay, Rajiv, and Srinivasan, 1997; Soh and Markus, 1995) have revealed that the impact of IT investments on organizational performance may not be a first order effect and may operate through a number of intermediate variables. These studies advocate studying IS value at the process or application level rather than at the organization level and constitute a second stream of research. Third stream of research revolves around the acceptance or rejection of technology by an individual with the objective of studying determinants of technology acceptance by an individual. This stream of research is based on the Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1975) and is premised on the assumption that behavioral intention is a determinant of actual behaviour. The essence of this line of research is captured through the Technology Acceptance Model (TAM) (Davis, 1989; Davis, Bagozzi, and Warshaw, 1989). TAM is based on the assumption that computer systems don't improve organizational performance if they are not used. TAM has also been extended to study IT usage and its impact on productivity (Goodhue and Thompson, 1995) at the individual level.

While all the three streams of research provide significant insights into the value of information systems in an organization at different levels, TAM based research can be used to study IS value at the atomic level, i.e. an individual, in contrast to the aggregate level (process, application, or organization) in other two streams of research. Such an approach could help us avoid some of the potential issues associated with aggregate level analysis. In this study, we build on the rich research tradition of linking behavioral antecedents of IS use and extend it to study IS value addition at individual level. Specifically, we focus on antecedents of IS-enabled individual productivity. Though "appropriate use" has been proposed as an important factor influencing IT impacts (Soh et al., 1995), it has been operationalized in a limited number of studies. In our research model, we incorporate "appropriate use" through the construct, nature of IS use. Through our present research, we aim to encourage and highlight the use of the TAM model for understanding value of information systems at an individual level.

In the next section, we describe our research model. We then describe our study of 485 IS users which provides the empirical basis for us to analyze the link between IS use and productivity. Following that, we address some of the shortfalls associated with many TAM based studies and address prospects for new TAM from the process research standpoint – especially when being used as a predictive model.

THEORETICAL FRAMEWORK

The key objective of this research is to understand the determinants of the value of information technology to an individual. In view of the existing IS value research, a productive approach seems to shift focus from the issue of whether IS creates value to how IS creates value (Soh et al., 1995). From this perspective, we chose to focus on understanding how an explanatory model for IS use can be useful to study determinants of individual productivity. Secondly, we analyze the relationship between the nature of IS use and IS-enabled productivity and whether this relationship holds across different IS applications.

We used a variant of TAM as it incorporates an important aspect of TRA. Venkatesh and Morris's (2000b) approach to extending TAM (into TAM-II) formed the starting point for our research. We extended TAM-II by focusing on the dependent variable of the model. Our study differs from many past studies in that it does not focus on adding new antecedents to the original TAM model. Rather, it focuses on the outcome variable (i.e. individual productivity) as opposed to the traditional dependent variables (intention to use or actual use) used in TAM. The productivity construct in our study is different from the perceived usefulness construct as it measures actual outcome while perceived usefulness measures the perception of usefulness of an application. Table 1 shows that relatively few researchers have focused on measuring individual performance or productivity based on the TAM model. The majority of TAM based research has either focused on studying the behavioral intention (Chau and Hu, 2001; Hong, Thong, Wong, and Tam, 2001; Agarwal and Prasad, 1999; Hu, Sheng, Chau, and Tam, 1999) (using it as a surrogate measure for actual behaviour) or in some cases, actual usage (Thompson, Higgins, and Howell, 1991; Adams, Nelson, and Todd, 1992, Straub, Limyem, and Karahanna, 1995).

Goodhue et al. (1995) studied the role of task-technology-fit on individual performance using TAM and demonstrated the significance of the relationship between individual performance and task-technology-fit besides actual usage. Task-technology-fit is akin to choosing or developing an appropriate technology to support the tasks performed by an individual. On a similar note, Soh et al. (1995) identify IT assets (useful, well-designed applications with flexible IT infrastructure having good "reach" and "range") as a necessary condition for observing IT impacts. However, they identify "appropriate use" as the mediating variable between IT assets and IT impacts. This suggests that once an "appropriate technology" has been implemented then "appropriate use" of that technology results in "IT impacts." From this perspective, the task-technology-fit construct proposed by Goodhue et al. (1995) seems to address one dimension of Soh et al.'s (1995) model. In our study, we chose to focus on "appropriate use" (Chin, Gopal, and Salisbury, 1997) by incorporating an additional construct named "nature of IS use" in our proposed model. This construct captures the essence of the IS use process and focuses on the attributes of the use process. Our motivation for incorporating this construct is two fold. First, it helps us to enhance our understanding about how IT value is created at the individual level by focusing on differences amongst individuals in terms of how they use a particular technology. Second, even though "appropriate use" or "quality of use" (Boudreu and Seligman, 2003) has been proposed in IS value research as one of the determinants of IS value, its operationalization has been limited.

The other construct in our proposed model (shown in Figure 1), productivity, as a measure of IS effectiveness, is premised on the use of IS. It is, therefore, reasonable to theorize, as have Delone et al. (1992), that IS use is an important determinant of productivity. . In our research model, we measure the IS use construct through self-reported usage for each of the applications.

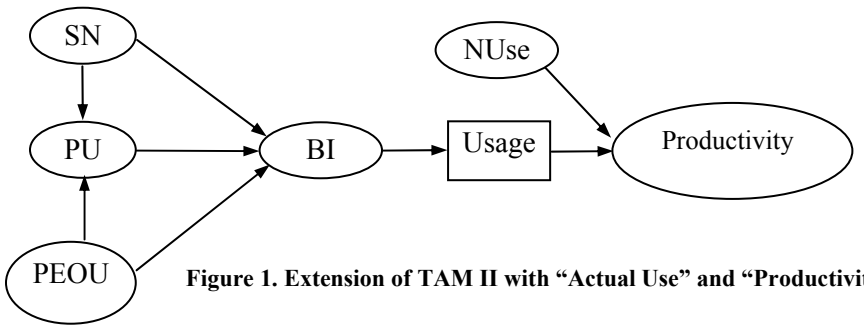


Figure 1. Extension of TAM II with "Actual Use" and "Productivity"

PU = Perceived Usefulness

PEOU = Perceived Ease of Use

SN = Subjective Norms

BI = Behavioral Intention

NUse = Nature of IS Use

Ovals represent latent variables and rectangles represent manifest variables.

We chose to not include task-technology-fit construct in our proposed model for two reasons. First, the applications we chose to study for this research, Email and Spreadsheet, are so widely and extensively used in contemporary organizations that these applications are considered to be inherently appropriate to tasks related to work processes. Second, Goodhue et al. (1995) have already established the relationship between task-technology-fit and individual performance. Therefore, our focus in this study was to build on their research and move beyond the appropriate technology argument to identify other important determinants of IS-enabled productivity.

Study	Category	Major Findings/Additions
Soh et al. (1995)	IS Use and Performance	Process model for IS value (IT Assets to IT Impacts)
Delone and McLean (1992)	IS Use and Performance	Use and User Satisfaction are direct antecedents of individual impact
Straub (1994)	Linked Use to Productivity	Link between Use and Productivity benefits using IT diffusion model
Goodhue et al. (1995)	Linked Use to Performance	Task technology fit (TTF) predict performance impact better than utilization; Task technology fit and utilization together are good predictors of performance
Thompson et al. (1991)	Measured IT Usage	Social factors, complexity, job fit and long term consequences have significant effect of PC usage; Affect and facilitating conditions do not influence PC usage significantly
Adams et al. (1992)	Measured IT Usage	Usefulness is related to usage but ease of use is relatively less important overall in determining use; Relative importance of ease of use and usefulness in influencing usage is different for different applications
Straub et al. (1995)	Measured IT Usage	PU and PEU are related to self-reported system usage but weakly related to objective measures of system usage
Taylor and Todd (1995)	Measured IT Usage	BI to Behaviour path is stronger for experienced users relative to inexperienced users; PBC to Behaviour path is stronger for inexperienced users relative to experienced users
Sjazna (1996)	Measured IT Usage	BI to Usage link is dependent on measurement method applied for usage; BI to Usage link is significant for self-report usage measures and insignificant for actual usage measures.
Chau et al. (2001)	Measured Intention to Use	PU impacts BI but PEOU does not impact BI directly; Path from SN to BI is not significant
Hong et al. (2001)	Measured Intention to Use	PU impacts BI strongly than PEOU
Hu et al. (1999)	Measured Intention to Use	PEOU has no impact on PU
Agarwal et al. (1999)	Measured Intention to Use	Individual differences have impact on PU
Agarwal and Karahanna (2000)	Extended TAM using Antecedents	Cognitive Absorption and Self-Efficacy added as antecedents to PEOU and PEOU, PU respectively
Venkatesh et al. (2000b)	Extended TAM using Antecedents	Subjective Norms added as antecedent, Gender and Experience added as moderators
Gefen and Straub (1997)	Extended TAM using Antecedents	Gender added as antecedent for PU, PEOU and Use
Mathieson, Peacock, and Chinn (2001)	Extended TAM using Antecedents	Perceived resources added as an antecedent to behaviour intention and perceived ease of use

Table 1: Review of TAM based studies

In this study, we tested the research model presented in Figure 1 across two IS applications – Email and Spreadsheet. A study by Karahanna and Limayem (2000) on email and voice-mail usage indicates significant differences in the use of two applications and posits that relations between use and beliefs are more complex than originally proposed in TAM. This points

to a possibility of the existence of different motivations to use different applications, which in turn, may impact productivity. From this standpoint, we find it important to analyze the effect of application type on the nature of IS use, including the productivity construct in our proposed model. The choice of these two applications was driven by three factors. First, given the ubiquitous nature of these two applications, results of this study will lend themselves to generalizability. Second, the focus of this study is on individual productivity. Both email and spreadsheet are often considered as part of office productivity applications. From this standpoint, these two applications seem more appropriately related to individual productivity than others. Finally, we wanted to test our research model across two applications, which are similar but at the same time also provide relatively different degrees of freedom to a user. For example, email is an institutional application and every employee is a presumed user. On the other hand, although a spreadsheet is considered a very useful tool, its use often depends on the nature of a user's tasks, and a user's predisposition to using spreadsheets, among other factors. The choice of two applications helped us operationalize the differences in the way the same application is used by different users.

METHODOLOGY

This section explains our sample and data collection procedure. The sample for our study consisted of 485 individual users in six organizations. The organizations chosen belonged to diverse industries; this was necessary to prevent industry bias. Since our research method is based on that of Venkatesh et al. (2000b), we used the same instrument as employed by them. The instrument is described in Appendix A. We validated our construct, nature of use, through a pilot test of 25 users. Results of this validation provided us the construct reliability of 0.79. Questionnaires were distributed to a random sample of all users in six organizations. A total of 700 questionnaires were distributed. In all, 482 valid and usable responses were received. Table 2 provides descriptive sample statistics.

Average age; Standard deviation of age; Number of responses	**Top management**	**Middle management**	**Supervisory**	**Operational**	**Total**
Males	46.6; 3.98; 10	35.27; 6.88; 105	34.5; 9.64; 30	33.81; 8.89; 152	34.84; 8.46; 297
Females	44.33; 5.59; 6	35.74; 7.47; 38	39.25; 8.98; 12	33.52; 10.05; 129	34.65; 9.84; 185
Total	45.75; 8.56; 16	35.40; 6.99; 143	35.85; 9.59; 42	33.65; 9.42; 281	34.62; 9.26; 482
Overall average age, Standard deviation	34.62, 9.26 years				

Table 2. Sample description

RESULTS AND ANALYSIS

There were 17 manifest variables and 6 latent variables in this study. These variables are described in Appendix A. We followed a two-step procedure based on an approach recommended by Anderson & Gerbing (1988). In step 1, a confirmatory factor analysis was carried out between the manifest variables and constructs in the model prior to testing the path model. We used the PROC CALIS module of SAS for this analysis. In step 2, the measurement model was modified so that it represented the theoretical (causal) model of interest. This theoretical model was then tested and revised until a theoretically meaningful and statistically acceptable model was found.

Measurement model

The theoretical model for this study consists of six latent variables. Of these, three are the same as those employed by Davis (1989). These include perceived usefulness, perceived ease of use, and intention to use. The fourth latent variable, subjective norm, has been taken from Venkatesh et al.'s (2000b) study. Each of the four latent variables was measured by at least 2 manifest indicator items. The fifth and sixth latent variables, "nature of use" and "productivity", were measured by incorporating three and two items respectively. For a model with good fit, both CFI and NNFI should be close to 1.0 (with thresholds of 0.85 and 0.9 for CFI and NNFI respectively). From Table 3, it can be inferred that a good fit exists between the sample data and the measurement model.

Construct and indicators	Standardized loading	t	Reliability	Error Variance	Variance Extracted Estimate
Latent factor #1 (Behavioral intention)			**0.9648**		0.9321
V1 (BI1)	0.9778	29.32	0.9560	0.04451	
V2 (BI2)	0.9545	28.06	0.9111	0.09157	
Latent factor #2 (Perceived usefulness)			**0.9369**		0.7879
V3 (PU1)	0.9139	26.08	0.8352	0.22266	
V4 (PU2)	0.9227	26.52	0.8514	0.18099	
V5 (PU3)	0.9150	26.14	0.8372	0.20734	
V6 (PU4)	0.8713	24.06	0.7592	0.27251	
Latent factor #3 (Perceived ease of use)			**0.8495**		0.5897
V7 (PEOU1)	0.7927	20.38	0.6283	0.35761	
V8 (PEOU2)	0.6264	14.83	0.3924	0.94360	
V9 (PEOU3)	0.9255	25.92	0.8566	0.15331	
V10 (PEOU4)	0.8263	21.68	0.6828	0.32619	
Latent factor #4 (Subjective norm)			**0.8937**		0.8082
V11 (SN1)	0.8644	20.20	0.7472	0.29704	
V12 (SN2)	0.9571	22.70	0.9160	0.09759	
Latent factor #5 (Nature of Use)			**0.7991**		0.5754
V13 (NU)	0.7060	15.63	0.4984	0.42902	
V14 (NU2)	0.5897	12.79	0.3477	0.49147	
V15 (NU3)	0.8472	19.16	0.7178	0.23343	
Latent factor #7 (Productivity)			**0.9382**		0.8836
V16 (PD1)	0.9513	27.38	0.9050	0.12021	
V17 (PD2)	0.9527	27.44	0.9077	0.11855	

Table 3. Properties of the measurement model

The Structural Model

The initial theoretical model (Model A) that we analysed is shown in Figure 1. The goodness-of-fit indexes for each model are shown in Table 4 in separate rows. Values for NNFI (0.9056) and CFI (0.9054) are acceptable for Model A. The nomological validity of the theoretical model was tested using the χ^2 difference test. The χ^2 value from the measurement model (322.94) was subtracted from the χ^2 value from the structured model (705.26), resulting in a χ^2 difference of 382.32. The difference in degrees of freedom was 13. Since the critical value of χ^2 was 22.36, the significantly large value of χ^2 shows that the theoretical model was successful in accounting for all the relationships between the latent and manifest constructs.

We followed this path analysis by subjecting the same model to a statistical control of application type. The fit indices and path coefficients for email and spreadsheet are shown in Table 4 and Table 5 respectively. For spreadsheet use, NNFI and CFI values are 0.8770 and 0.9039 respectively. For email, the NNFI and CFI values are 0.8899 and 0.9238 respectively. All these values are acceptable. However, we note from Table 5 that the path coefficient between subjective norm and intention to use is non-significant for both classes of applications (-0.0612 and -0.0748 in columns 4 and 6 respectively in Table 5).

Our next step was to conduct an empirical specification search (adding or dropping paths). We focused on the non-significant relationship between subjective norms and intention to use. Based on an adaptation of Venkatesh and Davis (2000a) model, we analyzed an alternate model in which subjective norm is linked to nature of use and the link from subjective norm to intention to use is removed. We have labelled this as Model B in Tables 4 and 5. Model B, for all situations i.e. overall data, spreadsheet application, and email application, shows higher than acceptable levels of goodness-of-fit and parsimony indices (NNFI and CFI are all greater than 0.9 except for one). While there is no statistically significant difference between Model A and Model B, all Models B are better than Models A. It is significant to note that the new path between subjective norm and nature of use is significant in Models B for pooled or overall data and spreadsheet application. However, this path (path coefficient of 0.1351) was not significant for the email application.

Overall	**Chi Square**	**D.F.**	**NNI**	**NNFI**	**CFI**	**χ^2/d.f.**	**RMSEA**	**RMR**
Model A	705.26	128	0.9056	0.9054	0.9210	5.50	0.096	53.04
Model B	629.48	127	0.9171	0.9156	0.9312	4.96	0.091	8.43
Email								
Model A	378.19	128	0.9089	0.8899	0.9238	2.95	0.09	45.12
Model B	342.77	127	0.9208	0.9002	0.9343	2.70	0.09	8.29
Spreadsheet								
Model A	518.20	128	0.8852	0.8770	0.9039	4.05	0.11	72.3
Model B	451.15	127	0.9038	0.8930	0.9202	3.55	0.10	74.47

Table 4. Goodness of fit and parsimony indexes

Model paths	**Overall[a]**		**Spreadsheet[b]**		**Email[c]**	
	Model A	Model B	Model A	Model B	Model A	Model B
PU-Intention	0.6381	0.6428	0.8358	0.8138	0.4602	0.4881
PEOU-Intention	0.2822	0.2824	0.1110	0.1097	0.3997	0.3847
PEOU-PU	0.5842	0.5745	0.5011	0.4831	0.6860	0.6770
SN-Intention	0.0148*	-	-0.0612*	-	0.0748*	-
SN-PU	0.2735	0.2965	0.3582	0.3937	0.1892	0.2163
SN-Productivity	-	0.3095	-	0.4034	-	0.2048
Intention-Use	0.3353	0.3251	0.4693	0.4668	0.2460	0.1191*
Use-Productivity	0.4342	0.3749	0.4649	0.3299	0.3144	0.0125*
Nature of Use-Productivity	0.3809	0.3376	0.3843	0.3133	0.3526	0.3331
SN-Nature of Use	-	0.2293	-	0.3282	-	0.1351*

Note: (a) N = 485; (b) N = 240; (c) N = 242; All path coefficients are significant at the 0.05 level except for those marked with an asterisk

Table 5. Structural model with path coefficients

DISCUSSION

The presence of a reasonable fit with the original TAM model (i.e. excluding subjective norm) suggested by Davis (1989) provided us the opportunity and justification for further analysis and investigation. In this section, we scrutinize the findings obtained in the previous section. We analyze the following relationships in particular: the relationship between nature of IS use and productivity, the relationship between actual use and productivity, and relationship between intention to use and actual use.

Nature of use and productivity relationship: The relationship between nature of use and productivity is significant in all three data sets and across all models. As we have discussed earlier, nature of use is akin to appropriate use. Our results indicate that the quality of the use process is as important as the extent or duration of use of an information system. The significant relationship between nature of use and productivity implies that how a user uses a system determines the quantum of value

that the user derives from that system. This finding is significant from the practical perspective because it provides insights into how IS value at the individual level can be enhanced by controlling the nature of IS use.

The actual use and productivity relationship: Next, we take up the relationship between actual use and productivity. Our results show that the path weights are significant and that these path weights vary between 0.4649 and 0.3144 except for Model B for email. We plotted the productivity data against actual use and observed a non-linear relationship between productivity and actual use. Our plot indicated that productivity increases initially with increase in usage but does not increase significantly at the higher levels of IS usage. It, in fact, decreases at higher levels of IS usage. This implies that we are attempting to fit a linear path to a relationship that is essentially non-linear. We derive important practical implications from this finding in implications section.

The intention and actual use relationship: The findings for the relationship between Intention→Use are along expected lines for both Model A and Model B for spreadsheet and overall data. However, in the case of email, Model A validates the findings by previous researchers (Adams et al., 1992; Straub et al., 1995; Thompson et al., 1991). However, for Model B, results are intriguing. While for all other models, Intention → Use relationship is significant, it is insignificant for Model B for email. The non-significant relationship for email in Model B can be understood as follows: even when an individual is not predisposed to using email, the individual ends up using the email system because of heavy dependence on emails in contemporary work life. We strongly recommend investigating these results further.

IMPLICATIONS AND CONCLUSIONS

This study has moved beyond TAM by introducing IS-enabled productivity and nature of use. The study has highlighted the importance of nature of use, which is a process variable. This has implications for theory as well as practice. The primary theoretical implication of our focus on the outcome variable, productivity, lies in framing a process theory oriented (Soh et al., 1995; Crowston, 2000; Kanungo, 2003) approach to technology acceptance. It is this very process based view of IT use than can be used to derive incremental value by manipulating the use process. From a practical standpoint, every user learns, or should learn, better and improved ways of accomplishing work tasks using IT. If a user does not do that, then, given the changes and uncertainties inherent in work practices, IT use stagnates into a tedious process. The performance of any process can be increased by dedicating additional effort to either work or improvement activities. However, the two activities do not produce equivalent results. Based on the work of Repenning and Sterman (2001), we can show that improving the IS use process is equivalent to working smarter while increasing IS use is equivalent to working harder. The essence of our findings is that when it comes to IS use, working smarter is far more preferable to working harder (more is not necessarily better when it comes to IS use). Working smarter leads to sustained improvements in how IT assets can be transformed into organizational value by the IS use process at the individual level.

Another important implication concerns limits to productivity when it is considered a consequence of IS use (regardless of the task). In other words, the more you use a system, the more productive you become. However, like all learning frameworks, there are natural limits to productivity increases (Sterman, 2000). Crossing such limits often leads to diminishing returns. An optimal manipulation of a blend of IS use and the nature of use may result in significant productivity gains at the individual level.

LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

Some of the limitations of this research include the lack of clarity regarding the nature of use construct and the less-than-sharp distinction between perceived usefulness and productivity. Further research is required to refine these constructs to advance our understanding of how nature of use affects IS enabled productivity. We also acknowledge the limitation of using two-item scale for behavioral intention in this study. We recommend that future studies need to focus on using constructs with a higher number of items and on verifying the results of this study.

REFERENCES

1. Adams, D.A., Nelson, R.R., and Todd, P.A. (1992). Perceived usefulness, ease of use, and usage of information technology: A replication, *MIS Quarterly*, 16(2), 227-247.
2. Agarwal, R. and Prasad, J. (1999). Are individual differences germane to the acceptance of information technologies?, *Decision Sciences*, 30(2), 361-391.
3. Agarwal, R. and Karahanna, E. (2000). Time flies when you're having fun: Cognitive absorption and beliefs about information technology usage, *MIS Quarterly*, 24(4), 665-694.
4. Allison, P. D. (1978). Measures of inequality, *American Sociological Review*, 43(6), 865-880.

5. Anderson, J. C. and Gerbing, D.W. (1988). Structural equation modeling in practice: A review and recommended two-step approach, *Psychological Bulletin*, 103, 411-423.
6. Boudreau, M-C., and Seligman, L. (2003). A Learning-Based Model of Quality of Use: Insights from a Case Study of ERP Implementation, *Diffusion Interest Group in Information Technology (DIGIT) Workshop*, Seattle, December 14, 2003.
7. Brynjolfsson, E. & Hitt, L. (1993). Is information systems spending productive? New evidence and new resul**ts,** In *Proceedings of 14th International Conference of Information Systems*, Orlando, Florida, pp. 47-64
8. Brynjolfsson, E. and Hitt, L. (1996). Paradox lost? Firm level evidence on the returns to information systems spending, *Management Science*, 42(4), 541-558
9. Brynjolfsson, E. and Yang, S. (1999). The intangible costs and benefits of computer investments: Evidence from the financial markets" *Proceedings of the International Conference on Information Systems,* Atlanta, Georgia, December, 1997. Revised in 1999.
10. Brynjolfsson, E. & Hitt, L. (2000). Beyond computation: Information technology, organizational transformation and business performance, *Journal of Economic Perspectives*, 14(4), 23-48.
11. Chau, P.Y.K. and Hu, P.J. (2001). Information technology acceptance by individual professionals: A model comparison approach, *Decision Sciences*, 32(4), 699-719.
12. Chin, W.W., Gopal, A., Salisbury, W.D. (1997). Advancing the Theory of Adaptive Structuration: The Development of a Scale to Measure Faithfulness of Appropriation, *Information Systems Research*, 8(4), 342-367
13. Crowston, K. (2000). Process as theory in information systems research," In IFIP WG 8.2 International Conference: The Social and Organizational Perspective on Research and Practice in Information Technology, Aalborg, Denmark. http://crowston.syr.edu/papers/ifip2000.pdf
14. Davis, F.D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology, *MIS Quarterly*, 13(3), 319-339.
15. Davis, F.D., R.P.Bagozzi and P.R. Warshaw (1989). User acceptance of computer technology: A comparison of two theoretical models, *Management Science*, 35(8), 982-1003.
16. DeLone, W.H., and McLean, E.R. (1992). Information systems success: The quest for the dependent variable, *Information Systems Research*, 3(1), 60-95.
17. Devraj, S. and Kohli, R. (2000). Information technology payoff in healthcare industry: A longitudinal study, *Journal of Management Information Systems*, 16(4), 41-67.
18. Fishbein, M., and Ajzen, I. (1975). Belief, Attitude, Intentions and Behavior: An Introduction to Theory and Research, Addison-Wesley, Boston, 1975.
19. Gefen, D. and Straub, D.W. (1997). Gender differences in the perception and use of E-mail: An extension to the technology acceptance model, *MIS Quarterly*, 21(4), 389-400.
20. Goodhue, D.L. and Thompson, R.L. (1995). Task-technology fit and individual performance, *MIS Quarterly*, 19(2), 213-236
21. Hong, W., Thong, J.Y.L., Wong, W.M., and Tam, K.Y. (2001). Determinants of user acceptance of digital libraries: An empirical examination of individual differences and system characteristics, *Journal of Management Information Systems,* 18(3), 97-124.
22. Hu, P. J. H., Sheng, O. R. L., Chau, P. Y. K., and Tam, K.Y. (1999). Examining technology acceptance model using physician acceptance of telemedicine technology, *Journal of Management Information Systems*, 16(2), 91-112 .
23. Kanungo, S. (2003). Using systems dynamics to operationalize process theory in information systems research, *Proceedings of the Twenty Fourth International Conference on Information Systems*, Seattle.
24. Karahanna, E. and Limayem, M. (2000). E-mail and V-Mail usage: Generalizing across technologies, *Journal of Organizational Computing & Electronic Commerce*, 10(1), 49-66.
25. Loveman, G.W. (1990). An assessment of the productivity impact on information technologies", MIS Management in the 1990s, Working Paper #88-054 (July, 1990).
26. Mathieson, K., Peacock, E., and Chinn, W.C. (2001). Extending the technology acceptance model: The influence of perceived user resources, *The DATABASE for Advances in Information Systems*, 32(3), 86-112.

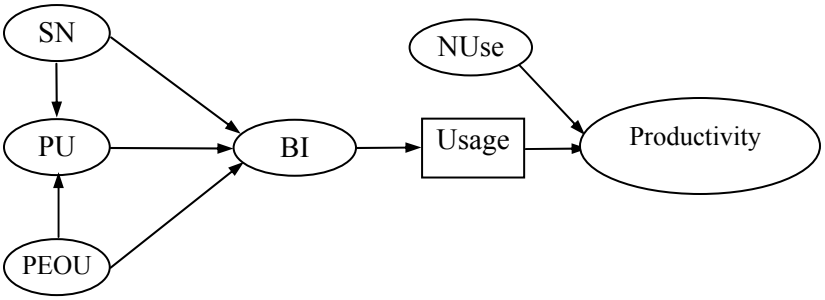
27. Mukhopadhyay, T., Rajiv, S., and Srinivasan, K. (1997). Information Technology impact on Process output and quality, *Management Science*, 43(12), 1645-1659.
28. Repenning, N. and J. Sterman (2001). Nobody Ever Gets Credit for Fixing Problems that Never Happened: Creating and Sustaining Process Improvement, *California Management Review,* 43(4), 64-88.
29. Roach, S.S. (1991). Services under siege –The restructuring imperative, *Harvard Business Review*, 69(5), 82-91.
30. Soh, C. and Markus, M. L. (1995). How IT creates business value: A process theory synthesis, *Proceedings of the Sixteenth International Conference on Information Systems*, 29-41.
31. Sterman, J.D. (2000). Business dynamics: Systems thinking and modelling for a complex world, Irwin McGraw-Hill, USA.
32. Straub, D.W., Limyem, M, and Karahanna, E. (1995). Measuring system usage: Implications for IS theory testing, *Management Science*, 41(8), 1328-1342.
33. Straub, D.W. (1994). The effect of culture on IT diffusion: E-mail and Fax in Japan and the U.S. *Information Systems Research*, 5(1), 23-47.
34. Szajna, B. (1996). Empirical evaluation of the revised technology acceptance model, *Management Science*, 42(1), 85-92.
35. Taylor, S. and Todd, P. (1995). Assessing IT usage: The role of prior experience, *MIS Quarterly*, 19(4), 561-570.
36. Thompson, R.L., Higgins, C.A., and Howell, J.M (1991). Personal Computing: Toward a conceptual model of utilization, *MIS Quarterly*, 15(1), 125-143.
37. Venkatesh, V. and Davis, F. D. (2000a). A theoretical extension of the technology acceptance model: Four longitudinal field studies, *Management Science*, 46(2), 186-205.
38. Venkatesh, V, and Morris, M.G. (2000b). Why Don't Men Ever Stop to Ask for Directions? Gender, social influence, and their role in technology acceptance and usage behavior, *MIS Quarterly*, 24(1), 115-139.

APPENDIX A: QUESTIONNAIRE ITEMS

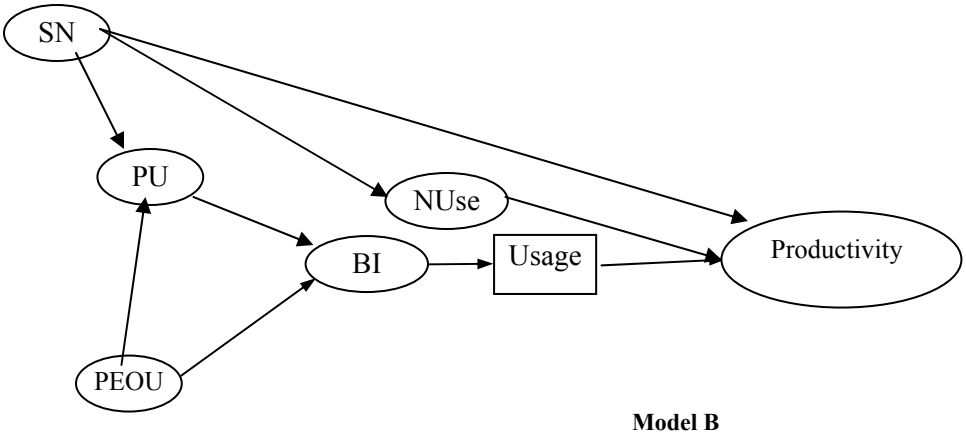
The following items (adapted from Venkatesh et al. (2000b)) were used in the questionnaire.

BI1 (V1)	Assuming that I have access to the email / spreadsheet, I intend to use it.
BI2 (V2)	Given that I had access to the email/spreadsheet, I predict that I would use it.
PU1 (V3)	Using email/spreadsheet improves my performance on the job
PU2 (V4)	Using email/spreadsheet increases my productivity (doing more in less time)
PU3 (V5)	Using email/spreadsheet increases my effectiveness (doing things better) on the job
PU4 (V6)	I find email/spreadsheet useful in my job
PEOU1 (V7)	My interaction with email/spreadsheet system is clear and understandable
PEOU2 (V8)	Using email/spreadsheet does not require a lot of mental effort
PEOU3 (V9)	I find the email/spreadsheet easy to use
PEOU4 (V10)	I find it easy to get the email/spreadsheet system to do what I want to do.
SN1 (V11)	People who influence my behavior think I should use email/spreadsheet
SN2 (V12)	People who are important to me think I should use email/spreadsheet.
NU1 (V13)	I am more organized when using email/spreadsheet than others
NU2 (V14)	I do things differently in email/spreadsheet than others
NU3 (V15)	My use of email/spreadsheet makes me more efficient than others
PD1 (V16)	The contribution of email/spreadsheet to my effectiveness (how well I do) is significant
PD2 (V17)	The contribution of email/spreadsheet to my productivity (how much I accomplish) is significant
Use	How many minutes do you spend every day using email/spreadsheet?

APPENDIX B



Model A



Model B